CLAIMS

1. A system for detection of several individual analytes in a test solution aliquot (83) with an array of individually operated piezoelectric crystal microbalances, comprising

a connecting station (100,101) for receiving and controlling an array of individually specific piezoelectric crystal microbalance flow-through cells (10), wherein each cell (10) comprises a cell compartment (34) containing at least one piezoelectric crystal (50) carrying two electrodes (56,62) and at least one coating (66,46) exposing a first member of an interaction pair specific for an individual analyte being a second member of the interaction pair to be detected in the test solution aliquot (83), the at least one coating being situated on (66) at least one of the electrodes (56,62) or at a distance from (46) said electrodes (56,62) in case either or both of the electrodes (56,62) have a coating (66) other than the coating exposing a first member of an interaction pair,

flowing means (70) for uninterrupted flowing of solution (75) and the test solution aliquot (83) to, and through, the cell compartment (34) of each of the individually specific cells (10) via the connecting station (100,101); and power and measurement means (130) for individually oscillating the piezoelectric crystal(s) (50) in each of the cell compartments (34) and measuring a change in oscillating characteristics of the crystal(s) (50) following interaction between the first member and the second member of the interaction pair to thereby detect presence of the individual analytes in the test solution aliquot (83) by the individually specific microbalances.

2. The system according to claim 1, wherein the individually operated piezoelectric crystal microbalances are electrostatically and electromagnetically shielded from each other.

3. The system according to claim 1, wherein the connecting station (100) comprises connection means (112) for serial interconnection of the flowing of the solution (75) and test solution aliquot (83) to and through the cell compartment (34) of the individual cells (10).

4. The system according to claim 1, wherein the connecting station (101) comprises connection means (113) for parallel connection of the flowing of the solution (75) and test solution aliquot (83) to and through the cell compartment (34) of the individual cells (10).

5. The system according to claim 1, further comprising grounding means (108) for electrical grounding of the flow solution (75) and the test solution aliquot (83) to the cell compartment (34) of each of the cells (10).

6. The system according to claim 1, wherein the connecting station (100; 101) comprises a connecting panel (112; 113) having an array of cell connecting receptors (118), each receptor comprising a receptor connector portion (120) for mating operative engagement with a cell connector portion (24), each connector portion comprising a pair of electric connecting ports (126, 128) for communication with said power and measurement means (130) and a pair of fluid connecting ports (122, 124) for communication with the flowing means (70).

7. The system according to claim 1, wherein the flowing means (70) comprises a solution feeding and flowing unit (72) having

a pump (76) for feeding and flowing the solution (75) from a reservoir (74) via a flow line (78) and a flow valve (86) to a flow line (98, 104) providing a flow of the solution to, and through, each of the cell compartments (34);

an insertion means (82) for introduction of the test solution aliquot (83) via a flow line (84), the flow valve (86) and a flow loop (90) to the flow line (98, 104) providing a flowplug of the test solution aliquot (83) to, and through, each of the cell compartments (34).

8. The system according to claim 7, further comprising a dually functional pulse dampener and degasser (80) downstream of the pump (76) in the flow line (78, 90, 98).

9. A system according to claim 1, wherein the first member of the interaction pair is an antibody reversibly bound to the coating (66, 46) and the second member of the interaction pair is an antigen present in the test solution aliquot (83).

10. A multiple piezoelectric crystal microbalance device comprising a connecting station (100,101) for receiving and individually operating an array of piezoelectric crystal microbalances comprising:

a connecting panel (112; 113) having an array of cell connecting receptors (118), each receptor comprising a receptor connector portion (120) for mating operative engagement with

a cell connector portion (24) of each piezoelectric crystal microbalance flow-through cell (10), wherein

each receptor connector portion (120) comprises

a pair of electric connecting ports (126, 128) for communication with a power and measurement means (130) for oscillating a piezoelectric crystal (50) carrying two electrodes (56,62) in a cell compartment (34) of one operatively engaged flow-through cell (10) and for measuring oscillating characteristics of the piezoelectric crystal (50); and

a pair of fluid connecting ports (122, 124) for communication with flowing means (70) for flowing a solution (75) and a test solution aliquot (83) to, and through, the cell compartment (34).

11. The multiple piezoelectric crystal microbalance device according to claim 10, wherein the individually operated piezoelectric crystal microbalances are electrostatically and electromagnetically shielded from each other.

12. The multiple piezoelectric crystal microbalance device according to claim 11, wherein the connecting station (100) comprises connection means (112) for serial interconnection of the flowing of the solution (75) and test solution aliquot (83) to and through the cell compartment (34) of the individual cells (10).

13. The multiple piezoelectric crystal microbalance device according to claim 11, wherein the connecting station (101) comprises connection means (113) for parallel connection of the flowing of the solution (75) and test solution aliquot (83) to and through the cell compartment (34) of the individual cells (10).

14. The multiple piezoelectric crystal microbalance device according to claim 11, further comprising grounding means (108) for electrical grounding of the flow solution (75) and the test solution aliquot (83) to the cell compartment (34) of each of the flow-through cells (10).

15. A method of detecting several individual analytes in a test solution aliquot (83), comprising the steps of

providing a connecting station (100,101) with an array of individually operated piezoelectric crystal microbalances having individually specific piezoelectric crystal

microbalance flow-through cells (10), wherein each cell (10) comprises, in a cell compartment (34)containing at least one piezoelectric crystal (50) carrying two electrodes (56,62) and at least one coating (66,46) exposing a first member of an interaction pair specific for an individual analyte being a second member of the interaction pair to be detected in the test solution aliquot (83), the at least one coating being situated on (66) at least one of the electrodes (56,62) or at a distance from (46) said electrodes (56,62) in case either or both of the electrodes (56,62) have a coating (66) other than the coating exposing a first member of an interaction pair,

uninterruptedly flowing a solution (75) and the test solution aliquot (83) to, and through, the cell compartment (34) of each of the individually specific cells (10) via the connecting station (100,101),

individually oscillating the piezoelectric crystal(s) (50) in each of the cell compartments (34) and measuring a change in oscillating characteristics of each crystal (50), a change in oscillating characteristics of the crystal (50) indicating interaction between the first member and the second member of the interaction pair,
thereby detecting the presence of the individual analytes in the test solution aliquot (83) by the individually specific microbalances.

16. The method according to claim 15, wherein the flowing of the solution (75) and test solution aliquot (83) to, and through, the cell compartment (34) of each of the individually specific cells (10), is arranged by serial interconnection of the compartments (34).

17. The method according to claim 15, wherein the flowing of the solution (75) and test solution aliquot (83) to, and through, the cell compartment (34) of each of the individually specific cells (10), is arranged by parallel connection of the compartments (34).

18. The method according to claim 15, wherein the first and second members of the interaction pairs are antibodies and antigens.

19. The method according to claim 15, wherein the several individual analytes in the test solution aliquot are selected from explosives and narcotics.

20. The method according to claim 19, wherein the explosives are selected from the group consisting of trinitrotoluene (TNT), dinitrotoluene (DNT), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazine (HMX), pentaerythritol tetranitrate (PETN), and nitroglycerine (NG).

21. The method according to claim 19, wherein the narcotics are selected from the group consisting of cocaine, heroin, amphetamine, methamphetamine, cannabinols, tetrahydrocannabinols (THC), and methylenedioxy-N-methylamphetamine (Ecstacy).

22. A disposable piezoelectric crystal microbalance flow cell (10) for use in an array of individually operated piezoelectric crystal microbalances (112) comprising:

a sealed cell housing (12) having external fluid and electric connector means (24) for interfacing with external solution flow, electric power and electronic control equipment (70, 130) on detachably connecting said flow cell (10) to a connecting station (100,101) of a sensor system, said electronic control equipment being designed for detecting a deviation from oscillating characteristics of an oscillating piezoelectric sensor crystal (50) in said housing (12) in response to said crystal changing its mass,

said sensor crystal (50) comprising a first face and a second opposite face, each having a respective metal electrode (56, 62) for oscillating said sensor crystal (50), and having a pair of contact patches (58, 64) for electrically connecting said electrodes (56, 62) to said station (100,101) via said connector means (24), the metal surface of the electrode on said first face (56) being the metal surface having a coating (66); and

isolating means (68) for fluidly isolating a compartment (34) comprising the coating (66) in the cell from said contact patches (58, 64), said fluid compartment (34) being adapted for fluid communication with said station (100,101) via connector ports (32, 30) of said connector means (24).

23. The flow cell according to claim 22, wherein the changing of mass of the crystal is a result of an interaction between a first member of an interaction pair attached to the coating (66) on the metal surface of the sensor crystal (50) and a second member of the interaction pair present in a fluid.

24. The flow cell according to claim 22, wherein said fluidly isolated compartment (34) comprises a first member of the interaction pair (38) separated from the coating on the metal surface (66) for activation of the coating with the first member prior to use.

25. The flow cell according to claim 22, wherein at a distance from the electrodes (56, 62), one of which contains the coating (66), is situated another coating (46) exposing a first member of an interaction pair, and the first member is reversibly bound to that coating (46) in solution, and in use, a second member of the interaction pair is present in a fluid, the first member is displaced from its coating (46) as it interacts with the second member to form the interaction pair, which is subsequently attracted and adsorbed by the coating (66) on the electrode resulting in a measurable mass enhancement on the electrode.

26. The flow cell according to claim 23 or 24, wherein said first member of the interaction pair is an antibody reversibly bound to the coating (66).

27. The flow cell according to claim 26, wherein said antibody is an antibody specifically binding to an explosive or a narcotic.

28. The flow cell according to claim 27, wherein the explosive is selected from the group consisting of trinitrotoluene (TNT), dinitrotoluene (DNT), hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX), octahydro-1,3,5,7-tetranitro-1,3,5,7-tetrazine (HMX), pentaerythritol tetranitrate (PETN), and nitroglycerine (NG).

29. The flow cell according to claim 27, wherein the narcotic is selected from the group consisting of cocaine, heroin, amphetamine, methamphetamine, cannabinols, tetrahydrocannabinols (THC), and methylenedioxy-N-methylamphetamine (ecstacy).

30. The flow cell according to any one of the claims 22-29, wherein the coating comprises two or more different attached first members of interaction pairs.

31. The flow cell according to any one of claims 22-29, wherein the coating is divided into two or more discrete patches each comprising different attached first members of interaction pairs.

32. The flow cell according to any of claims 22-31, wherein said connector means (24) is adapted for mating engagement with a connector portion (120) of the connecting station (100).

33. The flow cell according to any of claims 22 -32, further comprising support means (42; 43) for supporting said second face (60) of the crystal (50).

34. The flow cell according to any of claims 22 - 33, further comprising an electrical shield (109) enclosing the cell (10).
